Swedish National Road and Transport Research Institute

Cold and Semi-Hot Recycling of Asphalt Pavement in Sweden

by

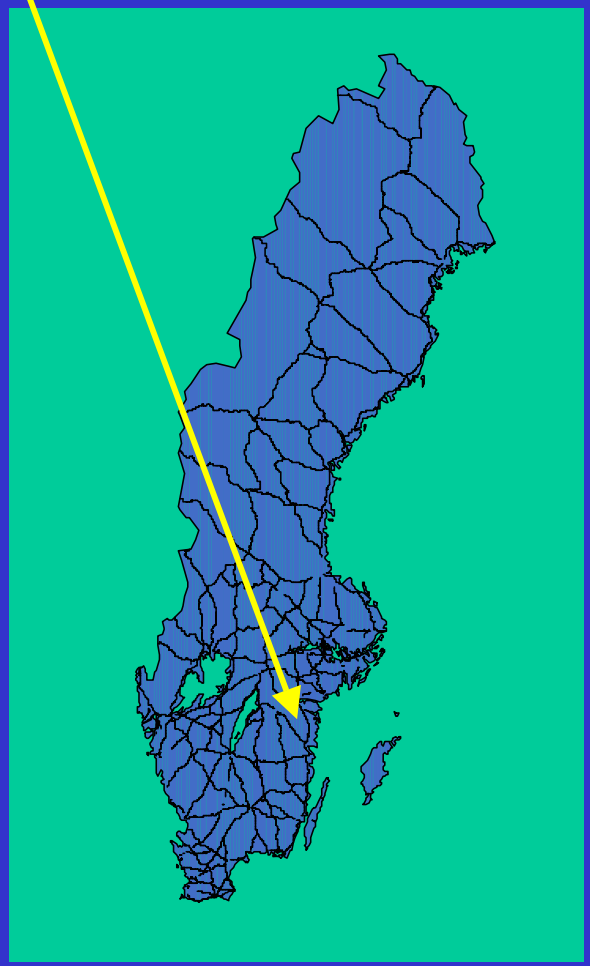
Torbjörn Jacobson

VTI

Swedish National Road and Transport Research Institute

Swedish National Road and Transport Research Institute

Asphalt pavements in Sweden



Asphalt production:

- 7 million tons of hot mix
- 1 million tons of cold or semi-hot mix
- 1 million tons of recycled asphalt

Wearing course:

- Surface dressing (30%)
- Cold and semi-hot mix (20%)
- Hot mix (50%)

Swedish National Road and Transport Research Institute

Recycling of Asphalt Pavement

- Cold recycling: 40%
- Semi-hot recycling: 35%
- Hot recycling: 25%

- Mix in plant
- Mix in place

Swedish National Road and Transport Research Institute

Reclaimed Asphalt Pavement (Asphalt Granulate)

Asphalt granulate

- Crushed or milled and sorted asphalt pavements
- 0-16 mm for wearing course
- 0-22 mm for road base
- Binder content: 3,0-6,0%

Swedish National Road and Transport Research Institute

Cold Recycling in Plant

- Bitumen emulsion: 2,0-4,0%
- Aggregate: 10-20%
- Asphalt granulate: 80-100%
- Optimal water content: 6-7%
- Total binder content: 4,5-7,5%

Swedish National Road and Transport Research Institute

Cold Recycling in Plant

- Easy to move
- Close location to the job site
- Continuous or batch mixer
- Modern control systems
- 100-150 ton per hour

Swedish National Road and Transport Research Institute

Cold Recycling in Plant - new binder

Standard

- BE60M/1500
- BE60M/6000
- BE60M/12000
- BE 60M/160/220

Special

- Nyrec 240/pen.330/430
- Nyrec 630/pen.160/220

Swedish National Road and Transport Research Institute

Semi-Hot Recycling in Plant

- Temperature: 50-80°C
- Batch mixing: 100-150 ton per hour
- Soft bitumen: 1,2-1,8%
- Asphalt granulate: 80-100%
- Aggregate: 0-20%

Swedish National Road and Transport Research Institute

Semi-Hot Recycling - new binder

- Soft bitumen
- 0,8-1,4 % adhesion agent (amin)
- V1500
- V3000
- V6000
- V12000

Swedish National Road and Transport Research Institute

Laying and Compaction

- Cold mix is relatively slow to lay
- Compaction with both steel and rubber tyre roller
- Newly laid pavements can be sensitive to mechanical stresses

Swedish National Road and Transport Research Institute

Laying and Compaction

Swedish National Road and Transport Research Institute

Cold Recycling - Mix in Place

- **Bitumen emulsion**
  - BE60M/160/220 and 330/430
  - 1,5-4,0% emulsion
- **Foamed bitumen**
  - 1,0-2,5% bitumen
  - adhesion agent (1%)
- **1-2% cement** improve water sensitivity and stability

Swedish National Road and Transport Research Institute

Semi-Hot Recycling - Mix in Place

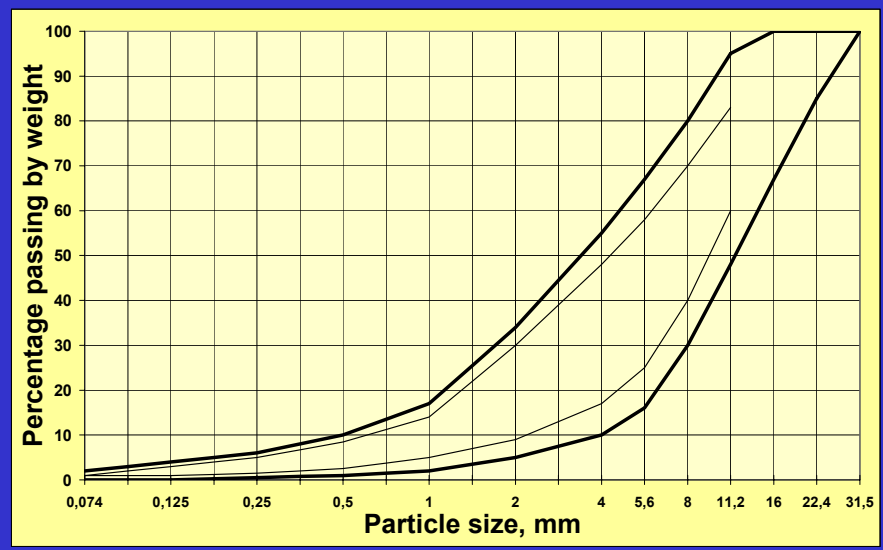
- Temperature: 50-80°C
- For soft bitumen asphalt pavement
- New binder, mix or aggregate is added
- Depth: 0-8 cm

Swedish National Road and Transport Research Institute

Laboratory tests - step 1

- Sampling
- Characterising old pavement material
  - Binder content, grading of extracted material
  - Compaction curve
  - Grading and moisture content of granulate
  - Penetration, softening point or viscosity of recycled binder

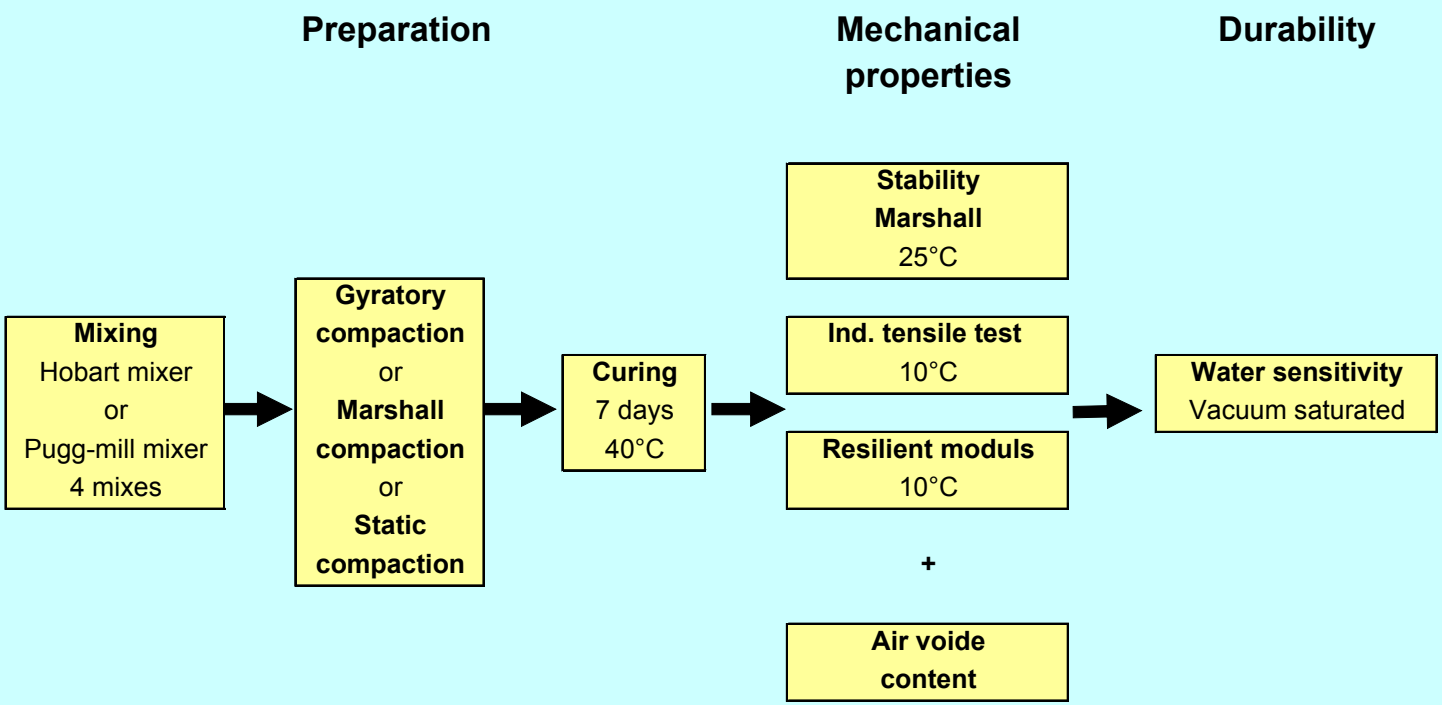
- Suitable particle grading for granulate:



Swedish National Road and Transport Research Institute

Laboratory tests - step 2

Mix design system for cold or semi-hot asphalt:



Swedish National Road and Transport Research Institute

Laboratory tests - step 2

Mix design

- Preparation of specimens
  - Mixing, compaction, curing
- Mechanical properties
  - Stability, Ind. Tensile test, Resilient modulus + air void content
- Durability
  - Water sensitivity

Preparation of test specimen

Swedish National Road and Transport Research Institute

Laboratory tests - step 3

Quality control

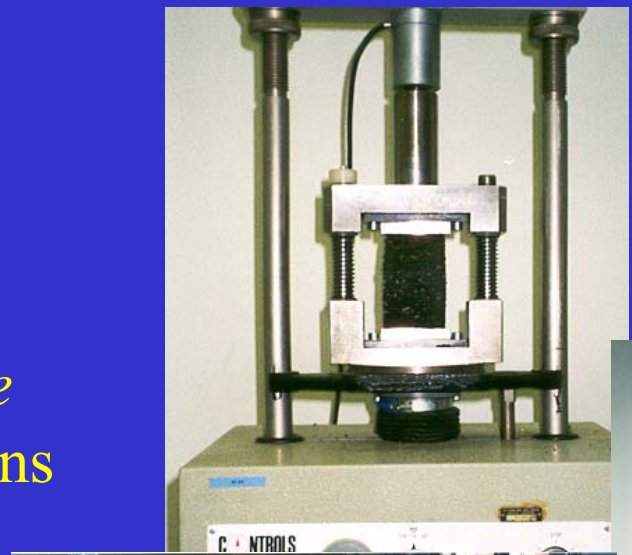
With low traffic volume

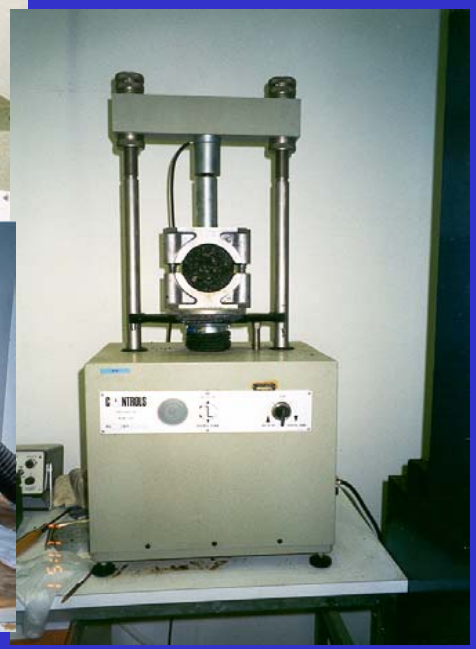
- Binder content and grading of mix

With higher traffic volume

- Preparation of specimens from mix, then:
- Mechanical properties
- Durability

Test equipment





Laboratory test - requirements for Cold Mix

Method	Road base	Wearing course
Void content, volume %:	6-14	4-12
Marshall stability, 25°C. kN:	>7	>5
Stiffness modulus 1), 10°C, MPa:	>2000	-
Ind. tensile strength, 10°C, kPa:	-	>300
Water sensitivity, %:	>50	>60

Swedish National Road and Transport Research Institute

Laboratory test - requirements for Semi-Hot Mix

Method	Road base	Wearing course
Void content, volume %:	5-10	3-8
Marshall stability, 25°C. kN:	>10	>8
Stiffness modulus, 10°C, MPa:	2000-5000	-
Ind. tensile strength, 10°C, kPa:	-	>500
Water sensitivity, %:	>60	>70

Asphalt Pavement is 100% Recyclable.
Thank you!